Potential for High Severity Fire: A New 30m Raster Dataset for the Western United States

Gregory K. Dillon[1*], Jason M. Herynk[2], Zachary A. Holden[3], Penelope Morgan[4] and Robin P. Silverstein[1]

[1]USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT USA; [2]Systems for Environmental Management, Missoula, MT USA;
[3]USDA Forest Service, Northern Region, Missoula, MT USA; [4]University of Idaho, Wildland Fire Program and College of Natural Resources, Moscow, ID USA

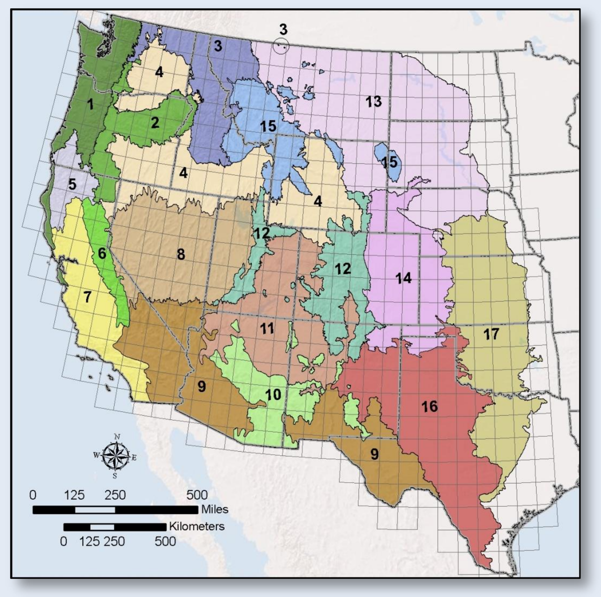
* Corresponding author: gdillon@fs.fed.us

OBJECTIVE

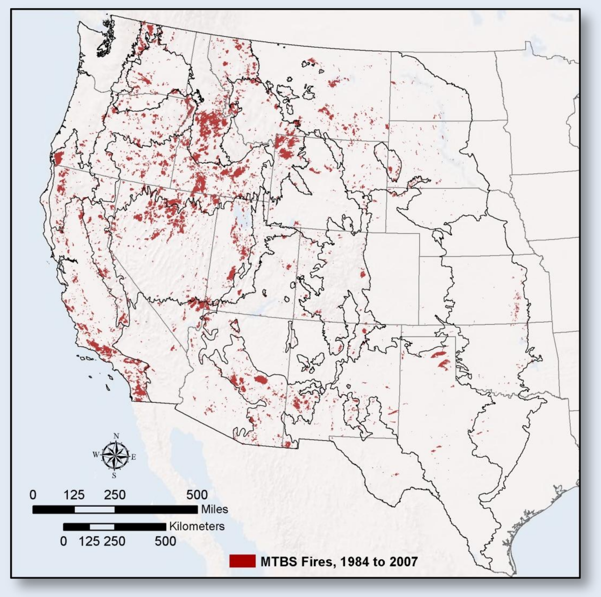
- Produce a seamless, wall-to-wall, 30-meter raster geospatial layer covering all lands in the western Untied States that:
  - builds on Monitoring Trends in Burn Severity (MTBS) data to make predictions;
  - depicts the potential for high severity fire for each 30-m cell, based on empirical observations and statistical modeling;
  - can be made available for managers and scientists to download.

INPUTS

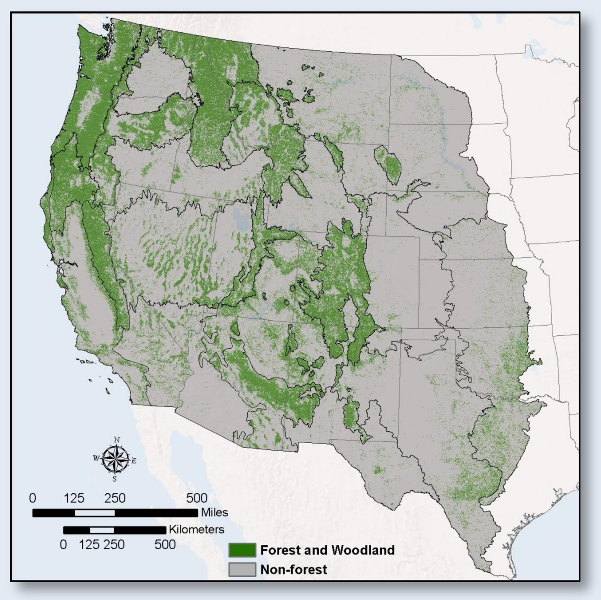
- We used 17 mapping regions to stratify statistical modeling.
- Mapping regions were based on US EPA Ecoregions.
- Raster spatial data for most predictors used in modeling were stored and processed in 1-degree tiles.

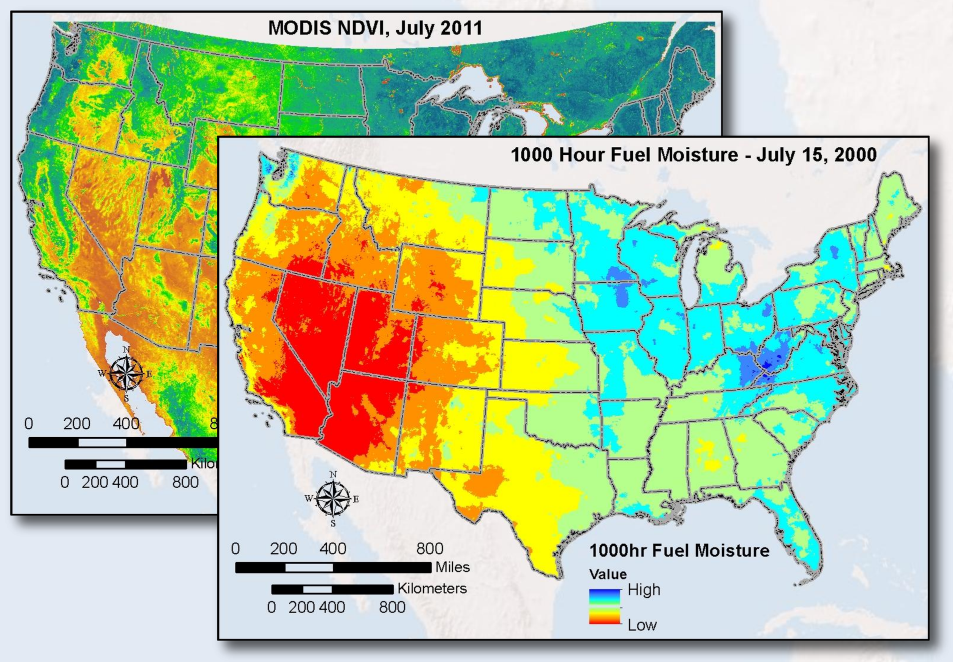


- Satellite-derived burn severity observations came from over 7,000 fires that burned between 1984 and 2007.
- We used the RdNBR mapped by MTBS, and classified it into discrete classes of high severity versus all other severity using over 3,000 Composite Burn Index plots.

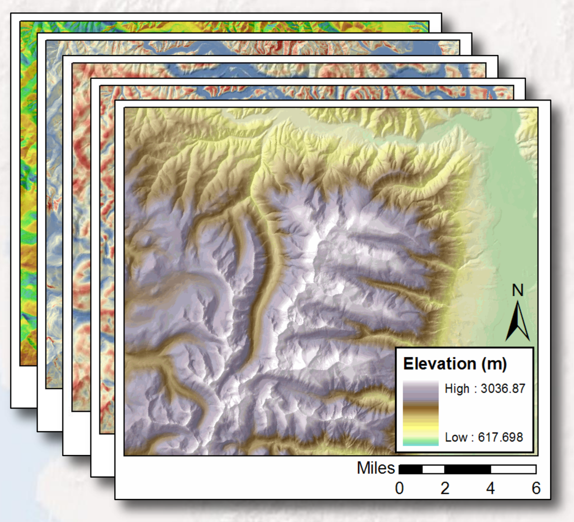


- Burn severity measurement and interpretation are very different in forest and woodland vs. non-forest settings; therefore, we kept them separate for modeling and mapping.
- We used a forest mask based on potential vegetation to stratify input data for modeling to capture pre-fire setting.
- We used a forest mask based on LANDFIRE Existing Vegetation Cover for making spatial predictions.

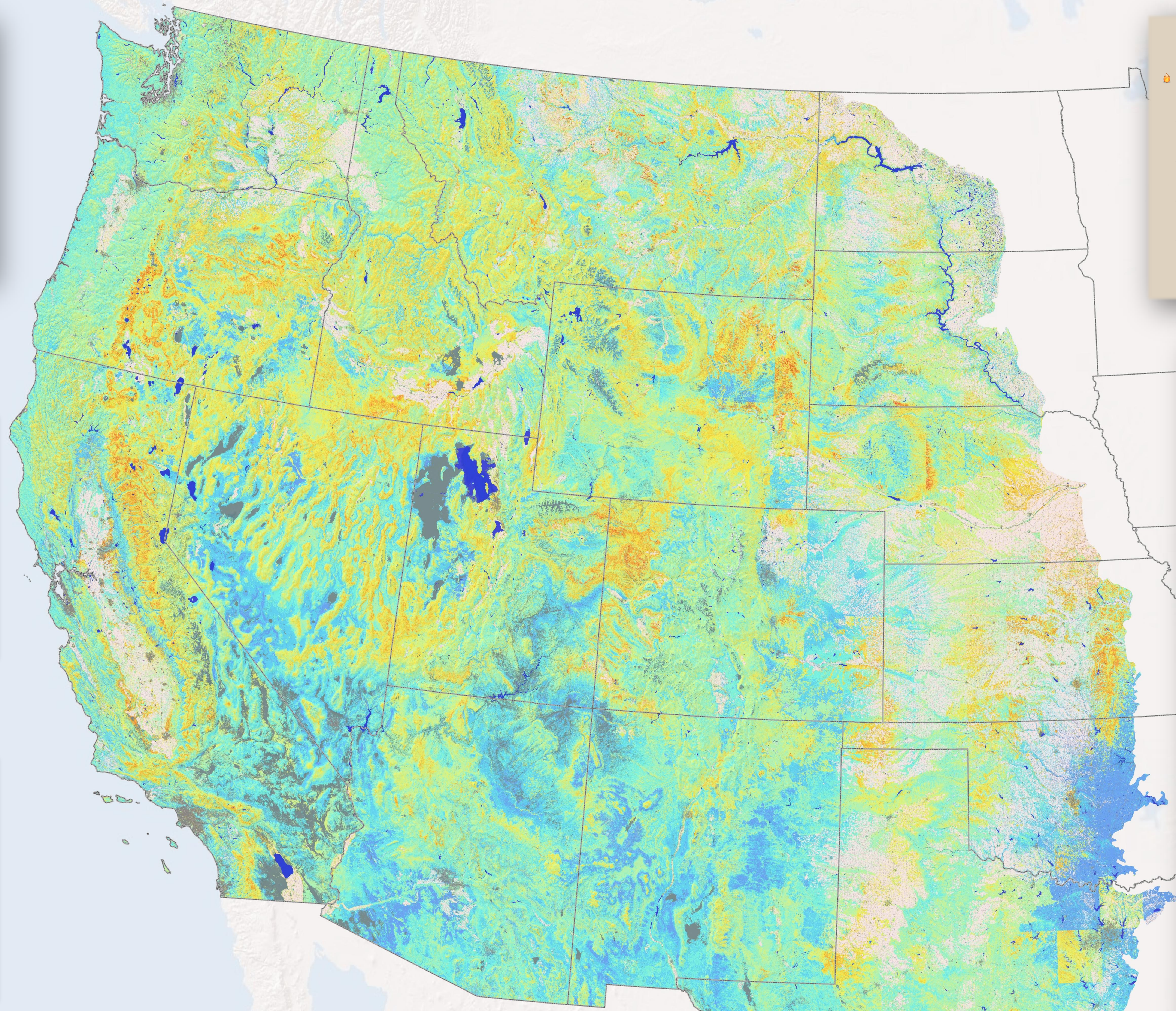




- Temporally-specific predictor data:
  - Normalized Differenced Vegetation Index (NDVI) from 30m LANDSAT (pre-fire) and 250m MODIS (current prediction)
  - 1000-hour fuel moisture from 4km downscaled NARR data (time-of-fire); set to 90th percentile conditions for current prediction



- Topographic predictor data:
  - 30m digital elevation from the National Elevation Dataset
  - 13 topographic derivatives including slope, topographic position, hierarchical slope position, topographic complexity indices, and maximum potential solar radiation



High Severity Fire Potential

0 - 9, 10 - 19, 20 - 29, 30 - 39, 40 - 49, 50 - 59, 60 - 69, 70 - 79, 80 - 89, 90 - 100

Nonburnable Lands

Water, Bare Ground, Developed, Snow / Ice, Nonburnable Agriculture

0, 200, 400, 600, 800 Miles

0, 250, 500, 750, 1,000 Kilometers

MODELING AND MAPPING

- Within each mapping region, we did the following steps separately for forest and woodland vs. non-forest settings:
  - Draw a spatially-balanced, random sample of 1% of burned pixels; extract values for all input layers at sample points.
  - Develop Random Forest classification tree models with binary severity response (high severity vs. not).
  - Use Random Forest models to predict every 30m pixel across the entire landscape to high severity or not.
  - Each Random Forest model calculates 1,500 classification trees. For every pixel, map the percentage of those trees that predicted the pixel to have high severity.

RESULTS

- Cross-validated classification accuracies for individual models ranged from 65% to 85% for forest and woodland models, and 69% to 82% for non-forest models.
- Elevation, 1000-hour fuel moisture, and NDVI were always in the top five predictor variables.
- Slope, broad-scale (2km) topographic position index, and/or solar radiation often rounded out the top five predictors.

Results for forest and woodland models:

		Sample Points				Random Forest Model Performance		
Region	Number of MTBS Fires	Number	High Severity	Other Severity	Number of Selected Predictor Variables	Classification Accuracy	Kappa	AUC
1	467	73,087	44%	56%	9	0.71	0.40	0.78
2	830	58,321	46%	54%	6	0.72	0.44	0.80
3	988	100,000	50%	50%	10	0.65	0.31	0.71
4	2,465	100,000	50%	50%	8	0.68	0.37	0.75
5	383	50,301	45%	55%	9	0.70	0.40	0.77
6	543	39,094	46%	54%	5	0.74	0.47	0.82
7	1,069	73,253	46%	54%	4	0.72	0.45	0.80
8	1,611	39,566	47%	53%	7	0.71	0.43	0.79
9	1,216	39,750	46%	54%	6	0.73	0.46	0.80
10	789	41,282	45%	55%	6	0.77	0.54	0.85
11	817	65,235	46%	54%	9	0.75	0.50	0.83
12	592	37,024	48%	52%	9	0.72	0.43	0.79
13	690	54,970	48%	52%	9	0.72	0.43	0.79
14	348	12,872	48%	52%	9	0.73	0.46	0.80
15	860	100,000	50%	50%	8	0.66	0.32	0.72
16	467	8,368	45%	55%	5	0.74	0.48	0.82
17	305	2,779	35%	65%	9	0.83	0.63	0.91

Results for non-forest models:

		Sample Points				Random Forest Model Performance		
Region	Number of MTBS Fires	Number	High Severity	Other Severity	Number of Selected Predictor Variables	Classification Accuracy	Kappa	AUC
1	467	27,749	41%	59%	9	0.74	0.46	0.82
2	830	100,000	50%	50%	7	0.75	0.50	0.83
3	988	100,000	50%	50%	9	0.76	0.52	0.85
4	2,465	100,000	50%	50%	7	0.70	0.41	0.78
5	383	15,598	40%	60%	9	0.72	0.42	0.79
6	543	35,289	42%	58%	9	0.73	0.45	0.81
7	1,069	100,000	50%	50%	9	0.74	0.48	0.82
8	1,611	100,000	50%	50%	7	0.69	0.38	0.76
9	1,216	100,000	50%	50%	9	0.74	0.48	0.82
10	789	34,112	37%	63%	9	0.76	0.49	0.83
11	817	54,758	39%	61%	9	0.77	0.52	0.85
12	592	78,222	40%	60%	9	0.76	0.50	0.83
13	690	93,560	47%	53%	4	0.74	0.48	0.82
14	348	23,447	43%	57%	5	0.79	0.58	0.87
15	860	100,000	50%	50%	9	0.77	0.54	0.85
16	467	27,979	40%	60%	9	0.78	0.54	0.86
17	305	2,743	35%	65%	6	0.82	0.61	0.90

For product download information, stay tuned to:
http://www.firelab.org/research-projects/fire-ecology/128-firesev

ACKNOWLEDGEMENTS: Funding for this work was provided in part by the Joint Fire Science Program under JFSP project # 09-1-07-4, and facilitated via RJVA 09-JV-1221637-270 between University of Idaho and USDA Forest Service Rocky Mountain Research Station.